REPORT ON METHODOLOGY FOR CONDUCTING RURAL ENERGY SURVEYS : A LITERATURE REVIEW AND DESIGN OF QUESTIONNAIRE

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Introduction

The project dealing with Rural Energy under the United Nations University's Energy Planning Programme was essentially designed to evaluate existing methodologies for data collection in this field. Consequently, the work performed as part of the project in 1983 dealt with the following elements:

i) <u>A thorough and detailed study of various surveys carried out on quantifying and understanding energy consumption in India</u>

A large number of studies have been undertaken in the past in this field, but many of them reveal gaps and weaknesses which are quite significant. Additionally, there is also a lack of consistency and coherence between different studies as a result of which uniform analysis and results cannot be obtained from any two studies. The report produced under this project, therefore, evaluates the methodologies, and the weaknesses and strengths characteristics each of the studies concerned.

ii) <u>An attempt at understanding the major linkages, causal factors and their effects in a range of rural energy consumption situations existing throughout India</u>

Again, this understanding has been arrived at on the basis of the work done in each particular study concerned in our survey. This understanding is essential for the design of an appropriate data collection system on the basis of which statistical estimates of energy supply and consumption patterns can be developed for the regions of India.

iii) <u>Designing of a detailed questionnaire on the basis of which a specific village could be surveyed and data collected to investigate the details of rural energy consumption in considerable depth</u>

Since, the emphasis in this study is basically on methodology, the questionnaire prepared has been made as comprehensive as possible. It is anticipated that modifications would become necessary once this work is actually undertaken in the field in the process of data collection. The questionnaire developed, therefore,

represents a theoretical ideal, which may have to be tempered by practical constraints and lack of easily available quantitative measures as is normal in Indian villages.

The questionnaire itself will, therefore, be finalised in the next phase of the study, but its detailed structure is included in this report.

This report is organised and divided on the basis of the various studies that have been surveyed, and the titles of the various sections follow the titles of the various reports. However, to provide a summary of the major objectives, coverage, and methodology of the different studies, we provide below a listing of the major literature surveyed with a brief description of objectives, coverage, a listing of the variables included and the gaps and weaknesses of each study. This is followed by a detailed description of each report in depth.

Notations — Literature Cited

A. National Council of Applied Economic Research, January 1981. Report on Rural Energy Consumption in Northern India, New Delhi.

B. National Council of Applied Economic Research, Volume 1 and Volume 11, 1978-79 'Domestic Fuel Survey with special reference to Kerosene', New Delhi.

C. Instituto De Economia Energetica, 'Rural Energy'.

D. Bowonder, B.; K. Ravishankar; S. Shivaram Prasad, March, 1983 'Energy Implications of Social Forestry', Centre for Energy Environment and Technology, Administrative Staff College of India, Hyderabad.

E. Gupta, C.L.; K. Usha Rao 'Energy Inputs for irrigated farming with mixed cropping', A micro level study on Pondicherry region.

F. Revelle, R., 'Energy Use in Rural India'. Science 4, June, 1976.

Objectives

A. Estimation of Energy Consumption in the Northern parts of rural India. It includes all aspects of rural activity viz. agriculture, domestic activity commerce, industry, transport and amenities.

B. All India Statewise energy consumption in the rural and urban areas with special reference to consumption, demand, penetration level in rural areas and impact of kerosene on rural electrification. Also development of an econometric model for future forecast of kerosene demand for lighting and heating.

C. To analyse the existing relationships and the production methods used between agriculture and cattle production in Latin American countries.

D. Impact of social forestry on energy supply and environmental characteristics.

E. To quantify energy input in agriculture (with special reference to human energy) for different agricultural activities with respect to variables like crops, agricultural operations, land holding and yield of crops.

F. To obtain the National Energy Consumption Statistics for the year 1970-71 with special emphasis on energy requirements met by the Traditional Sources of Energy in India.

Coverage

A. Purposewise consumption of different types of fuels for parameters like season, environment, income, purchase vs. collection and mode of transport in rural areas of Northern India and includes various sectors such as agriculture, domestic, commerce, industry, construction, transport and amenities. Also, case studies were presented to see the potential of seven gobar gas plants and lastly the impact of firewood plantations in rural activities.

B. All India statewise energy consumption in households (according to income) and selected establishments both in rural and urban areas with particular emphasis on kerosene consumption. Also, an econometric model, each for demand forecast of heating and lighting purposes are discussed.

C. Situations prevailing in agricultural and cattle production sectors in Latin American countries:

   i) Agricultural production :- soil preparation, sowing, cultivation and harvesting

   ii) Cattle production :- breeding and fattening

   Also, the social, economic and cultural factors affected by the sectors production method is covered and lastly an input variable matrix showing technological activities vs. biogeographical areas for the application of those inputs variables into different production functions are covered.

D. Selection of four villages from different socio-economic and agroclimatic conditions, to study the impact of social forestry on energy use, the relationship between energy use and income variations. Also, a special effort has been made to study the collection patterns of various non-commercial fuels.

E. Analysis of all the primary energy inputs to agriculture and a comparative study has been made

for land use, yields and sourcewise energy inputs for a village each in Pondicherry, Karnataka and Punjab.

F. Estimation of human and animal energy. The consumption statistics for both traditional and commercial fuels in rural India in 1970-71. A comparison has been made between the use of energy from different sources for rural India and the United States.

Methodology

A. A large scale sample survey with a two stage stratified design. First stage units are the villages selected by using probability proportional to population. Also, the second stage units are the households from the selected villages by using systematic sampling. Size of the first stage unit is 100 villages and the size of the second stage unit is 1500 households.

B. Urban areas

A three stage stratified design. First stage units are towns and cities selected by probability proportional to population. Second stage units are the number of blocks within the sample towns or cities, selected by simple random sampling, and for the third stage, households were selected from the selected blocks by systematic sampling. First stage unit size is 312 towns or cities, second stage unit size is 600, the size of the block and the third stage unit size is 5060 households.

Rural areas

Same as in study 'A'. First stage unit size is 600 villages and the second stage unit size is 7500 households.

C. Formation of a matrix on bio-geographical area vs. technological activities which will act as inputs in formulating different types of production functions, necessarily for different production processes.

D. Complete enumeration in all the four villages.

E. Ten percent of the total households were surveyed.

Variables Included

A. Energy sources; energy inputs, environment and season, energy consumption in different sectors, collection and purchase of fuels, number of households and their annual income. Ownership of gobar gas plant, land utilisation statistics, food-grain consumption, energy utilising devices, types of establishments, labour employed, sales data of fuel depots, distance of household from the source of collection, health problems resulting from smoke in kitchen.

B. Annual income of households and its classification, energy consumption in households, types and end-uses of fuel consumed, sources of collection, and its distance from the household, reasons for shifting from one fuel to another, types of kerosene lamps and average hours of use per day and type of establishments.

C. Climatic conditions, agricultural production, operation and equipment, cattle production, technology adopted, energy and non-energy inputs and their use.

D. Number of members, their occupation and average annual income of the household, nature of environment, forest plantations (in hectares.), irrigated land availability and irrigation method used, initial investment and return per hectare, number of animals, milk and dung yield per animal, use of traditional and commercial fuels, usage of energy by sectors, agricultural production, productivity per hectare, fuel, fodder and vegetable production.

E. Land holding size, family data, farm characteristics, livestock categories, cropping pattern, energy requirements for pre-harvesting, harvesting and post harvesting operations, use of fertilizers and insecticides in the farms, usage of agricultural and animal waste.

F. Occupation of the rural population, energy in the food intake and work output per capita, measurement of oxygen inhaled or carbondioxide exhaled, energy in fodder intake, dung and milk, production of food grains, straw and chaff and dung, use of commercial and non-commercial fuels, use of petroleum products in farms for tractors and for irrigation purposes.

Gaps and Weaknesses

A. Only for the household sector distribution of total energy utilised is given whereas for the other sectors actual energy consumption figures are missing. Also, the consumption of different fuels in different seasons like summer and winter according to environmental classification is not given. Types of equipment used which consume energy is also not covered and finally no information is provided for the total cow-dung consumption for gobar gas plants and as fertilizers in agriculture.

B. The assumption that was made in this paper regarding the consumption pattern being same, for all India as in Northern India is not totally justified as there would be substantial difference in energy consumption due to the factors like climate, agricultural production etc. In correct specification of the term coefficient of dispersion, no information is provided for the proportion of weight allocated to rural areeas to that of the urban. Also, the consumption of individual fuels in different seasons is not covered and finally the efficiency factors of different utilizing devices are not discussed.

C. Type of production functions used for determining the cattle production and agricultural production are not discussed.

D. Does not stress the importance of choosing the right species of trees to be grown to suit the climatic and social conditions of the area. Also it has not covered the effect of burning fuelwood on public health and lastly the transport sector has been ignored.

E. The paper does not cover the sampling design and the norms used to make the estimation. Nor has it stated how the human and animal energy is used in work. And, lastly though the data has been collected, in terms of the size of land-holdings (large, small and marginal) data has not been analysed.

F. Absence of scientific basis on which the author either bases his estimates or borrows other authors' estimates. Nowhere is any reason for adopting particular estimate given.

REVIEW OF THE REPORT ON 'DOMESTIC FUEL SURVEY WITH SPECIAL REFERENCE TO KEROSENE

- National Council of Applied Economic Research

1. Objectives

The objectives of the study as taken from the report are given as under:

- To provide statewise estimates of the consumption of all forms of energy (both commercial and non-commercial) in the rural and urban areas, with special reference to kerosene. The economic sectors covered in the study were:

    - households, both rural and urban
    - all rural commercial establishments
    - all rural industries
    - selected urban establishments

- To determine accurately the demand for kerosene separately for:

    - lighting and cooking
    - each state/union territory
    - urban and rural areas separately within each state

- To find out the penetration level of kerosene in rural areas, with particular reference to inherent weaknesses in the existing kerosene oil, distribution system, particularly in rural areas.

- To assess the impact of rural electrification and its effect on kerosene demand for lighting

- To assess the relative economies of using different fuels for cooking, and the critical price at which kerosene could be substituted by alternate fuels or vice-versa in rural areas where the cheap alternate fuels are readily available

- To assess the availability of competing fuels

- To develop a computer model for forecasting kerosene requirements from time to time on the basis of relationships obtained from the survey without resorting to a field survey on each occasion.

2. Coverage

This study, 'Domestic Fuel Survey with special reference to Kerosene', deals with energy consumption in households and selected establishments in both the rural and the urban parts of India which cover all states and union territories of India, excluding Sikkim, Andaman and Nicobar Islands, Dadra Nagar Haveli and the Laccadive, Minicoy and Amindive Islands.

The survey was designed in 1978-79 to provide statewise estimates of consumption of different fuels, with particular reference to kerosene. The economic sectoral breakup for different types of energy consumption are covered and are:

- households, both rural and urban;
- all rural commercial establishments;
- all rural industries;
- selected urban establishments

Since, a variety of fuels (commercial as well as non-commercial) were consumed in the different sectors with different energy consumption units, in order to make aggregation of comparison between any two energy units possible, they were converted into the corresponding coal-replacement figures. The whole report is divided into two volumes. Volume I deals with the analysis and interpretation of the data. Here the sample design and the methodology for the study is also described. Whereas, in Volume II, the lists of different tables are presented, on individual fuels by income groups, and by states at the all India level, separately for rural and urban areas.

2.1 Coverage in Volume I

(a) **Areas covered through case s udies**

- The areas covered through case studies have shown energy consumption figures much above the national average.

- It was found that the villages with lower income groups depend mostly on non-commercial energy and have a share of about 90% in the total energy consumption, whereas in urban areas, over one third of the energy consumption is met through commercial fuels.

- Among non-commercial types of energy, fuelwood contributed more than 50% towards the energy need in both the rural and urban areas, whereas, among the commercial types of energy, kerosene was the most important fuel which accounted for more than 60% of the energy consumed.

(b) Areas covered through the sample survey

The 18 major states and union territories of India were covered through the sample survey. These states have an estimated population of 641 million, with 109 million households. The rural areas with over 75% of the population in these states accounted for 72% of the energy consumption in the household sector. Both the per capita and per household consumption of energy was less in the villages as compared to towns.

2.1.1. Energy Consumption in the Household Sector

In the household sector, fuel is consumed for:

- Cooking
- Lighting
- Water heating
- Space heating

Both commercial as well as non-commercial fuels were used in this sector. These are in the following forms:

- Kerosene
- Liquified petroleum gas (LPG)
- Town gas (coal gas)
- Soft coke
- Electricity
- Firewood
- Charcoal
- Dung cake
- Crop wastes

The commercial fuels are entirely purchased: the non-commercial fuels in rural areas are mostly collected.

- Estimated figures of energy consumption and the distribution of households for the major states covered through the sample survey, are given income-wise for both the rural and the urban areas.

- Analysis of the data showed that there is a disparity in the consumption of fuel between households belonging to different income categories. This disparity was found in both the rural and urban areas. It was found that the energy consumption in the higher income groups increased nearly three-fold as compared to lower income groups.

- The households consume fuels for a large variety of purposes and among the end uses, cooking by far, had the biggest share.

- One interesting point is that there is a negative correlation between household income and the share of fuel used for cooking. Actually, this is nothing but the famous Engel's Law, which states that 'the

percentage of income spent on food declines as income increases'.

- Figures are given for end usage pattern of fuels by income.

- The tables for 'the distribution of households purchasing or collection of different fuels are provided for both rural and urban areas.

- Fuelwood was collected from several sources, like the respondents own farm, road-side bushes and trees, forests and other sources as in the form of wages in kind. Tables giving sources of collection of different fuels (non-commercial) are shown.

- In this study, an attempt was made to split the fuelwood consumption between twigs and logs, as in earlier studies it was found that distinction between logs and twigs as fuelwood was not made and, therefore, the consumption figures, which included both twigs and logs were not strictly comparable with the production figures.

- The trend in the pattern of fuel consumption, percentage wise in the rural areas of northern region in 1975-76 and 1978-79 for different types of fuels, are given and from the table, it is found that the overall per capita consumption did not change, but the share of commercial fuel was marginally higher in 1978-79. Also, the table for the comparison of collectors of different fuels in the rural areas of the northern region in 1975-76 and 1978-79 are given.

- A table is also provided for distribution of households replanting trees by income group.

- In winter, energy consumption is more than that in summer, because in winter a number of factors escalate energy requirements:

- higher food intake in winter
- more time needed to boil water due to the low pressure and the low temperature in winter
- need for hot water for bathing and washing clothes.

It was found that the energy consumption in winter was 15% more than that in summer. This increase was not found to be uniform in other parts of the country.

2.1.2. Energy Consumption in Establishments

- Rural establishments include the following type:

  - Manufacturing units
  - Trade and Commerce
  - Services
  - Communications

  Whereas the urban establishments include

  - hotel, hostels, restaurants and eating houses,
  - hospitals
  - laundries, dry cleaning and drying plants
  - vegetable vendors

It was found that nearly two-thirds of the fuel consumed in this sector was met by commercial sources in both the rural and urban areas.

- Tables for energy consumption in establishments by types and that of various fuels are given both for rural as well as urban areas.

- Again, there are tables to show the pattern of fuel consumption by type of establishments in rural as well as urban areas.

2.1.3 Energy Consumption in both Househo ds and Establishments

- Consumption of energy in rural areas as well as urban areas by type of fuel consumed is given for both households and establishments. It was found that of the total energy consumption, two-thirds was consumed in rural areas.

- Statewise estimates of consumption of energy for both households and establishments is also given.

- Chapter V of this report deals with the consumption of energy by states.

2.1.4 erosene -onsumption

- Kerosene is used for dual purposes viz. lighting and cooking.

- An analysis, of the fuel preference indicated by households, revealed that, in general, households go for fuel with the following qualities:

  - Convenience
  - Easy to ignite
  - Cleanliness and less time for cooking
  - Hygienic conditions and good preparations
  - Non smoky
  - Easy to store

- In cities, the level of consumption of kerosene was more than twice that of the villages. It was found that more than two-thirds of the households had an average consumption below the overall average. Also, the distribution of households by kerosene consumption was found to be a bell-shaped curve and uni-modal. It was also a highly

skewed distinction with a large variance.

- The Lorenz ratio is the design of income concentration and is calculated below the line of equal distribution or below the degree of inequality in the distribution. Thus, the Lorenz ratio, which is given for the different economic variables like consumption of kerosene (statewise) and household income and wealth, and it was found that kerosene consumption was more concentrated than household income, while its concentration was less than the concentration of household wealth.

- Tables for the relative distribution of households by the kerosene consumption in the urban and rural areas are given. Also, tables showing percentage distribution of kerosene consumption by levels of consumption groups and by states for both rural and urban areas are given.

- Distribution of kerosene consumption by rural and urban areas with income classification is presented at the state level.

- Consumption figures for kerosene used for lighting and cooking or heating are presented in this report.

- Table showing distribution of electrified households by alternate sources of light by income class is also given. Kerosene lamps and candles are also used as alternative sources for lighting.

- A table which shows distribution of rural households by distance of source of purchase of kerosene has also been given.

- The price of kerosene varies from state to state. A table is, therefore, provided to show the comparison of the actual price of kerosene with statutory price of kerosene. The statutory price of kerosene includes the cost of transporting kerosene from one place to another.

- A fuel preference table, indicating the households preference of fuel for cooking is given percentage-wise, also, the major reasons for preference of one fuel over the other in both urban and rural areas has been shown by incomewise classification.

- An interesting fact that was brought out during the reference period of the survey, 1978-79, was that there are four major fuels which households prefer, and shift among:

  - soft coke
  - gobar gas
  - L P G
  - kerosene

The reason for these fuel shifts are also provided in a tabular form.

- A table for availability of different fuels used at an all India level has also been given.

- Changes in the pattern of fuels used have been discussed.

- The potential for LPG in the rural and urban areas in 1978-79 statewise is covered in the report. To estimate the use of LPG in 1978-79 in urban areas, the following data was assembled for each income group:

  - proportion of households using LPG
  - proportion of non-users of LPG opting for this fuel
  - proportion of households not willing to shift to LPG because of cost restraints among those who had opted for this fuel
  - average consumption of LPG

2.1.5 Demand or Kerosene in 1985-86

Finally, estimates of demand for kerosene in 1985-86 were attempted through an econometric model for each state, both in rural and urban areas, and for the two major uses of kerosene, namely, heating and lighting. Estimates are also given separately for the household and the establishment sectors.

I) Household Sector

Before going into the econometric model, the following steps were found to be important:

- identification of one or more variables which influence the consumption of kerosene;

- evolving a functional relationship between the consumption of kerosene and the variables identified earlier;

- forecasting the value of the identified variables for the year 1985-86;

- estimating the value of the variables on the functional relationship already estimated.

A number of factors affect the demand for kerosene:

- kerosene
- spread of rural electrification
- proportion of electrified houses
- urbanisation
- literacy
- price of kerosene relative to other fuels
- increase in population
- availability of alternate fuels

Some of these variables were used for the demand model for lighting, some were used for the demand model for

heating and some for both. But, it was found that the consumption of kerosene for lighting in the urban areas, and the consumption for heating in rural areas was so low that no meaningful relation- ship could be obtained. In view of this, only two courses were available:

- to estimate the heating and lighting demand for the state as a whole and then to split it between the rural and urban areas, or;

- to estimate the consumption of kerosene for lighting in villages and for heating in cities, certain proportions for the areas not covered, to arrive at the total.

In this report, the former method was adopted.

Since this is a problem of time projection, time series data would estimate more precisely the relationship and the stability of the coefficients between the dependent and independent variables, over time, compared to cross-section data. Here, again, as time series data was not available, cross-sectional data was utilised. In all, 19 observations were used for the heating model.

A. Data Base and Method of Production

The data base and the method of projecting the values of independent variables for 1985-86 are presented below:

i) Per-capita kerosene consumption

Per capita statewise consumption of kerosene for lighting and heating was taken from the survey data.

ii) Per-capita income

Estimates of per capita income statewise, were available from two sources for the year 1978-79, one from the National Income Division of the Central Satistical Organisation and the other from the present survey. Both the figures were at current prices. The two sets of figures were more or less similar, so that for the present exercise, the CSO figures were used. To estimate the state income figures for the year 1985-86, two sets of growth rates were one assumed that the per capital real national income would grow by 10% between 1978-79 and 1985-86,and the other assumed a 15% increase. The corresponding state income figures were estimated on the

assumption that the relative growth rates in the per capita income between states would remain constant. The projected per capita income figures were also at 1978-79 prices. This is discussed under a separate heading in the last part of the paper.

iii) Rural electrification

From the Rural Electricity Corporation (REC) figures for the number of villages electrified for each state for the past few years were obtained. The data corresponding to the year 1978-79 was used. R.E.C. also provided estimated target figures for rural electrification by 1985-86, 1985-86 targets were suitably modified on the basis of past performance and used for projections.

iv) Proportion of households electrified For the year 1978-79, the data on proportion of households electrified was taken from the present survey. These proportions for the year 1985-86 was estimated as follows:

It was seen earlier that household income had a high correlation with the proportion of households electrified. Using income distribution for the base year 1978-79, the proportion of households electrified at each income group and a projected income distribution for the year 1985-86, incorporating the changes in per capita income, the number of households likely to be electrified in 1985-86 was worked out.

But in the rural areas, apart from the rise in income, additional villages electrified between 1978-79 and 1985-86 would also affect the number of households electrified. It is further assumed that the income distribution of the new villages getting the benefits of electricity would be similar to the non- electrified villages of 1978-79. Thus, three income distributions were estimated. These were:

- for villages that were electrified prior to 1978-79

- for villages that are likely to be electrified between 1978-79 and 1985-86

- for villages that would remain non-electrified by 1985-86

The growth in population between 1978-79 and 1985-86 for those three groups was assumed to be the same. Accordingly, the income distribution for these villages was worked out for 1985-86. Merging the distribution of the first two groups of villages, the income distribution of electrified villages in 1985-86 was obtained. Using this and the proportion of households electrified at each level of income as observed in the survey, together with assumed changes in per capita income, the proportion of households likely to be electrified in 1985-86 was estimated. This procedure was carried out for both rural and urban areas separately and, hence, the estimated number of households for both the rural and urban areas were added together and expressed as a proportion of total households electrified in 1985-86.

v) Urbanisation

This variable is defined as the proportion of urban population to the total population. The base year figures as well as estimates for 1985-86 were taken from the Registrar General's estimates of population projections.

vi) Literacy

The proportion of the literate population for each state for the base year 1978-79 was obtained by interpolating the figures available in the 1971 and 1981 census. For 1985-86 the same procedure was followed.

vii) Relative prices

$$\text{Relative price} = \frac{\text{Price of kerosene}}{\text{Weighted average price of alternate fuels used for heating}}$$

The fuels considered here were:

- L.P.G.
- Soft coke
- Firewood

- Electricity
- Dung cake
- Crop wastes

The average price paid by the consumers for these different fuels in each state were obtained from the survey data. These were weighted with the consumption of these fuels for heating and an average was taken. Then the required ratio was determined to get the relative price. The ratio was assumed to remain constant till 1985-86.

B. <u>Heating Model</u>

The endogenous variable considered for this model was per capita demand of kerosene and LPG for heating. Whereas the exogenous variables were:

- income
- urbanisation
- relative prices
- literacy
- *dummy variable

Keeping all these variables in mind, step- wise multilinear regression equations were tried and finally comparing R^2, t and F values of all the equations, the following equation was selected. The regression co-efficient for only the literacy variable turned out to be insignificant. It was, therefore, dropped and the final analysis was based only on three exogenous variables and one dummy variable.

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*(It was seen earlier that the demand for heating in the hill regions was more due to the low temperature and high altitude. To correct this in the model, a dummy variable 1 was introduced for the states of Jammu and Kashmir, Himachal Pradesh and Meghalaya, and 0 for other states)

The model was:

$$HF(1) = a_0 + a1\ X1(i) + a2\ X2(i) + a3\ X_3(i) + a_4 D(i) + e(i)$$

where

$HF(i)$ = per capita demand of kerosene and LPG for heating in terms of C.R. for state i.

$X_1(i)$ = percentage of urban population to total population in state i

$X_3(i)$ = ratio of price of kerosene to weighted average price of other heating fuels in state i or, relative price in state i

$X_2(i)$ = per capita income in 1978-79 of state i

$D(i)$ = a dummy variable which took the value 1, for Jammu and Kashmir, Himachal Pradesh and Meghalaya, and;
0, for all other states; for state i

$e(i)$ = error term of state i

Thus, the estimated equation along with the 't' values of the regression coefficient are given below:

$$HF(i) = \underset{(0.49)}{-6.91964} + \underset{(7.02)}{1.38192}\ X_1(i) + \underset{(2.24)}{0.0174052}\ X_2(i)$$

$$\underset{(2.39)}{-25.8667}\ X_3(i) + \underset{(3.07)}{22.2724}\ D(i)$$

R^2 = 0.926

(Figures in brackets indicate 't' value)

This model, however, could not be used directly to estimate the demand for kerosene in 1985-86. For, in a few states the difference between the observed and estimated consumption for the base year 1978-79 was more than the likely increase in demand between 1978-79 and 1985-86, as a result of the growth in income and

urbanisation. In view of this, the following formula was used to project the demand for 1985-86

$$D_{85-86} = C_{78-79} + (E_{85-86} - E_{78-79})$$

where

D_{85-86} = Demand for petroleum fuels for heating 1985-86

C_{78-79} = Consumption of petroleum fuels for heating 1978-79

E_{85-86} = Demand for petroleum fuels for heating as estimated by the model for 1985-86

E_{78-79} = Consumption of petroleum fuels for heating as estimated by model in 1978-79

In other words, this model was used to estimate the likely increase in demand between 1978-79 and 1985-86 due to growth in income and urbanisation.

After estimating the demand for petroleum fuels in 1985-86, the next step was to split this between its constitutent units namely kerosene and LPG. While no statistics was available at the all India level, the study done by N.C.A.E.R. for the northern region indicated that between 1975-78, the kerosene use for heating grew at 9.5% as against a growth rate of 35% LPG during the same period.

In the absence of any other data, it was assumed that this relative growth rate would continue between 1978-79 and 1985-86 for the Northern as well as for other parts of India.

Accordingly, the demand for kerosene for heating in 1985-86 was worked out as follows:

where,

= consumption of kerosene for heating in 1978-79 in the state

= consumption of LPG in 1978-79 for the jth state

= consumption of kerosene and LPG for heating in 178-79 in the jth state

= demand for kerosene and LPG for heating in 1985-86 in the jth state

Using this formula the demand for kerosene for heating was worked out for each state individually with per capital income growth rate as 10% and 15%.

C. Lighting Model

For the lighting model, the following variables were used:

X_1 = per capita income

X_2 = percent of villages electrified

X_3 = percent of houses electrified

X_4 = proportion of literate population to the total population

D = *A dummy variable with the value 1, for Orissa and Rajasthan O, for all other states

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*(For the two states Orissa and Rajasthan, the observed consumption of Kerosene for lighting was well below the estimated figures. To take care of this constraint, in the demand model a dummy variable D was introduced which had value 1, for Orissa and Rajasthan and O for other states)

The estimated equation was:

$$L(i) = \underset{(1.85)}{2.03442} + \underset{(2.65)}{0.00294588}\, X_{1}(i) + \underset{(2.83)}{0.063588}\, X2(i)$$

$$- \underset{(1.75)}{0.01927}\, X_{3}(i) - \underset{(3.77)}{0.091959}\, X_{4}(i) - \underset{(3.22)}{2.34165}\, D$$

$$R^2 = 0.71$$

(Figures in the brackets are 't' values)

For estimating the demand for lighting in 1985-86, the approach was basically the same as in the case of heating.

d) Projection of State Income for 1985-86

The national income division of the Central Statistical Organisation had estimated state income for the year 1978-79 and few years prior to that. Based on that data with two alternate growth rates in per capital income,

- 15% growth in the all India per capita income between 1978-79 and 1985-86
- 10% growth in the all India per capita income between 1978-79 and 1985-86

the projection had been made for the state income for 1985-86.

It was assumed that the relative growth rate in per capita income of the different states between 1978-79 and 1985-86 would be the same as the one observed prior to 1978-79. Accordingly, the following formula was used to estimate the likely growth in the per capita income of different states between 1978-79 and 1985-86

$l_i = k\, g_i$

where $k = \dfrac{P\bar{Y} - P_i x_i}{P_i g_i x_i} = \dfrac{\text{Planned growth}}{\text{Past trend growth}}$

l_i = growth rate in per capita income between 1978-79 and 1985-86 for state i

g_i = growth rate in per capita income for the ith state prior to 1978-1979.

P_i = estimated population in the ith state in 1978-79

X_i = per capita income of the ith state in 1978-79 at current prices

$\bar{Y}$ = per capita income of the country in 1985-86

p = estimated population of India in 1985-86

II. Establishment Sector

The number of workers in each type of establishment in the rural and urban areas for each state was projected for the year 1985-86, using the inter census growth rates. It was also assumed that the average energy consumed per worker would be at the same level as in 1978-79. Accordingly, the total demand for energy of various types was worked out for the establishment sector in 1985-86. It was further assumed that the pattern of fuel consumption would not undergo a change between 1978-79 and 1985-86. Using the share of kerosene observed in 1978-79, estimates of demand for kerosene, both for lighting and for heating were worked out for the year 1985-86.

2.2. Coverage in Volume II

All the data collected were analysed and compiled in tabular forms and was published in volume II of this report. The following types of information, as summarised from the report, are obtained:

2.2.1 Household Sector

- Consumption of various fuels by end users
- Number of users of various fuels
- Quantities purchased and collected
- Major sources of collection of different non-commercial fuels
- Distribution of households not using preferred fuels for cooking by fuel use and the reasons for not using prefered fuels
- Availability of the different fuels used
- Substitution of one fuel for another during a fuel shortage
- Practices followed in collection of fire-wood by states
- Changes in fuel consumption pattern during the last five years by states
- Reasons for shift to present fuel, kerosene or LPG for cooking by states
- Availability of kerosene, LPG and electricity by states
- Distribution of electrified and non-electrified households by electrified and non-electrified places by states
- Pattern, quantity and share of fuel used for lighting for electrified and non electrified households by types of fuel and by states
- Distribution of households by fuel preferred for cooking and reasons for preference- all India
- Distribution of households by kerosene consumption group and income group
- Distribution of kerosene consumption (quantity) by kerosene consumption group and income group - all India

- Percentage of kerosene consumption for both heating and lighting, to kerosene consumption by state

- Percentage of households using fuels by type and size of town - all India

- Consumption of energy by size of town and by type of fuel

- Per capita consumption of energy by size of town and by type of fuel - all India

- Distribution of rural households by distance of source of purchase of kerosene by states

- Pattern of fuel consumption by states for both the household and establishment sectors.

2.2.2 Establishment Sector

- Estimated consumption of different types of fuels in rural and urban areas of the establishment sectors by states

- Percentage distribution of fuel in establishments

- Norm of fuel consumption by major category of employment in establishments

- Average per worker fuel consumption in establishments by states

- Distribution of fuel consumption by type and by major category of employment in rural and urban establishments.

3. Methodology

This report gives energy consumption figures at an all India level for various states and union territories, and covers the following economic sectors.

- Households, both rural and urban

- Rural industries

- Other commercial establishments, both in the rural and urban areas.

The methods of estimation of energy consumption were different for each of these sectors. These are discussed in detail below:

3.1 Household Sector

3.1.1. Sampling design & determination of sample size - Rural areas

The sampling design adopted for the large scale sample survey for rural areas was a two-state, stratified design. The first stage involved the selection of villages by using probability proportional to population*, and in the second stage, the selection of households was made from the selected villages by using systematic sampling. (Systematic sampling is a sampling method in which the first unit is selected with the help of random numbers, the rest being selected automatically, according to a pre- determined pattern. Thus, suppose a population consists of N units, serially numbered from 1 to N, and that N is expressible as a product of two integers k and n, so that N = kn. Draw a random number less than or equal to k, say i, and select the unit with the corresponding serial number and every kth unit in the population thereafter, clearly, the sample will contain the n unit i, i+k, i+2k, ...i+(n-1) k; such a sample is known as a systematic sample)**.

On the basis of earlier studies, it was found that the margin of error on average annual house- hold consumption of kerosene for individual states in northern parts of India was much more than that of India overall, so it was decided to fix the sample size based on the magnitude of error present in each state. With this in view, the coefficients of dispersion at the state level in northern India were worked out and given in tabular form. It was found that the major component of this error was the variation between the first stage units i.e., the districts in the stratum. And, thus the reduction in the estimate of standard error was made by increasing the number of sample districts, without increasing the size. But, since there was no other study available for other parts of India excepting the northern region, it was assumed that the same is true

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* Refer to review of the report on '<u>Rural Energy Consumption in Northern India</u>', NCAER.

**Sampling theory of surveys with applications - P.V. Sukhatme and B.V. Sukhatme

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**Sampling theory of surveys with applications - P.V. Sukhatme and B.V. Sukhatme

for other parts of India. That means each state selection of all the district, two villages were selected according to probability proportional to population and from each of the selected villages on an average, 15 households were selected by using systematic sampling.

The size of the number of households in rural India was fixed at 7,500 selected from 300 districts and 600 villages from all over India.

3.1.2 Sampling design and determination of sample size - Urban areas

For fixing the total sample size in urban areas, it was assumed that the optimum allocation between rural and urban areas is achieved when the sampling fraction is proportional to the standard deviation. But the standard deviations of the distribution of kerosene in urban and rural areas were 37.6 litres and 15.6 litres, respectively.

The sample size of the urban areas was thus calculated as given below:

Urban Households			Rural Households		
N_u	=	20,000,000	N_r	=	80,042,689
n_u	=	?	n_r	=	7,500
f_u	=	?	fr	=	$\frac{nr}{Nr}$ = 0.0000937
	=	37.6 lit	Sr	=	15.6 lit

where N, denotes the population size, n, denotes the sample size, $f = \frac{n}{N}$ denotes the sampling fraction, S, denotes the standard error, u denotes the urban areas and r, denotes the rural areas.

Since, the assumption is

$$\frac{Su}{fu} \qquad \frac{sr}{fr}$$

$$f_u = \frac{S_u f_r}{S_r}$$

$$= \frac{37.6 \times 0.0000937}{15.6}$$

$$= 0.000226$$

But, $N_u = 20,000,000$

$$n_u = f_u \times N_u = 0.000226 \times 20,000,000$$

$$= 4,500 \text{ (approx)}$$

Hence, the size of the sample households in the urban sector was 4,500.

Thus, having decided the sample size, the next step was the design of sampling for urban households. The actual selection of households in urban sectors was done by using a three stage design. In the first stage, towns or cities were selected. In the second stage blocks were made within the sample towns, and in the final i.e., the third stage, households, within the selected blocks were selected. These are discussed in detail later.

3.1.3 Primary Sampling units - Rural

The total number of districts covered in this study was 354. The population of these districts varied from 1 million to over 6 million in each case. Those districts, which were small in population size, were merged together, and these having a large population size were split into two halves with approximately equal population. After all these adjustments were made, the total number of districts came down from 354 to 300. Then each of these 300 districts was treated as a separate stratum. From each stratum two villages were selected by probability porportional to population. Thus, the number of villages selectedwas 600.

3.1.4 Primary sampling units - Urban

The definition of urban area was taken from the 1971 census report. According to the 1971 census, the total number of cities and towns in India were 2972. But on

the basis of an earlier study* it was found that bigger towns showed a larger variation in the average household consumption of energy. Hence, it was decided to stratify the towns on the basis of their population for the urban sample. The size of the population varied from less than 10,000 to over 500,000 and in this report, towns were stratified into seven groups as:

- over 500, 000
- 200,000 to 499,999
- 100,000 to 1,99,999
- 50,000 to 99,999
- 20,000 to 49,999
- 10,000 to 19,999
- under 10,000

The number of towns to be selected from each stratum was determined by proportional allocation i.e. by giving more weightage to a bigger sized population as compared to a smaller sized population. The proportional allocation was carried out independently for each strata. The actual selection of the town was made with probability selected out of over 2972 towns.

3.1.5 <u>Second stage units - Urban</u>

The National Sample Survey Organisation (N.S.S.O.) has divided each city/town into a number of blocks for their sampling frame. A sample of these blocks was taken from each of the selected towns (first stage unit). The number of blocks in a town varied between 2 and 20, depending on the size of the town. One block in a town had approximately 600 as the population size. The selection of blocks per sample town or city was done by using simple random sampling. Simple random sampling is done such that the probability of selecting any unit in any draw is the same or, in other words, units are selected with equal probability.

* Survey of soft coke in northern region - by NCAER

3.1.6 <u>Final sampling units</u> - <u>Both rural and Urban</u>
<u>Second stage unit</u> - <u>Rural areas</u>
<u>Third stage unit</u> - <u>Urban areas</u>

As households were the final sampling units for both the rural and urban areas, a specifically designed proforma was used to list out all the households in the selected blocks in urban areas and all the selected villages in the rural areas.

The following type of information was collected from each of the households in the selected villages in rural areas, and in the selected blocks in the urban areas:

- household location
- name of the household head
- household size
- occupation of the chief earner
- ownership of gobar gas plant
- annual income of households

After this information was collected, the households were stratified into five groups, viz:

- low, with an annual income of Rs.3,000 and below (L)
- lower middle, with an annual income between Rs. 3,001 and Rs. 6,000 (LM)
- Middle, with an annual income between Rs.6,001 and Rs. 12,000 (M)
- Upper middle, with an annual income between Rs.12,001 and Rs.18,000 (UM)
- High, with an annual income above Rs. 18,000 (H)

For purposes of comparison, it was decided to use the same levels of income stratification in both the rural and urban areas.

The relative sampling fraction for L, LM, M, UM and H households was then worked out, because variation in the upper income groups. This was done separately for rural and urban areas. Using these relatives, the overall sampling fractions for the five income strata in the urban and rural areas were derived. These fractions together with the probability of selection of sample blocks/villages determined the sampling fractions within blocks/villages for the five income strata. The inverse of these sampling fractions were the sampling intervals used for selection of households within the sample blocks/villages, using the method of systematic sampling.

Of the total number of 12,500 households, both in the rural and urban areas, information was available for about 12,000 households.

In addition to the above sample, case studies of about 75 households each from the union territories of Tripura, Mizoram, Nagaland, Arunachal Pradesh, Manipur and Ladakh were also done to provide estimates of kerosene consumption in these areas.

3.2 Establishment Sector

Fuels are also consumed in commercial and industrial units. The quantum of fuel consumption by these sectors was estimated on the basis of a sample survey covering 8,000 units of different types spread all over the country. Since the present study is mainly concerned with kerosene consumption, emphasis was laid on these units which were likely to consume this fuel. Establishments in the rural areas are of the following types:

- manufacturing units
- trade and commerce
- service
- communications

And, establishments in the urban areas are:

- hotels, restaurants and eating houses
- hospitals

- laundries, drycleaning and dying plants
- vegetable vendors

Thus, when information was collected on the village schedule, care was taken to include all varieties of establishments in each sample village. The total number of sample units, thus selected was around 3,200 in rural areas.

This procedure, however, could not be adopted in urban areas, where a list of establishments was not available. Hence, the method of quota sampling was adopted. For each sample town, a fixed number of units of different types, depending on the size of the town, were selected. The interviewers were instructed to canvass information on units of both small and large sizes. In addition to personal canvassing, the main questionnaire method was also adopted. The number of urban sample units, thus came to around 4,000.

Separate questionnaires were prepared for each type of establishment. The information collected in these schedules was:

- type of establishment
- average monthly turnover
- consumption of fuel (quantity)
- types of kerosene lamps used

4. Variables Included

For the analysis part of this report, data was collected for the following items:

- Number of districts (rural areas) for each state
- Number of cities/towns (urban areas) for each state
- Number of villages (rural areas) for each district

- Size of towns (according to population)
- Number of blocks in each selected cities
- Number of selected villages from each district
- Number of blocks selected from each selected city
- Number of households in the selected blocks of each selected city
- Number of households selected out of the total households
- Name of the head of the household
- Household location
- Household size
- Income of the family
- Classification of income according to lower income, lower middle income, middle income, higher middle income and upper income
- Energy consumption in households
- Types of fuel consumed
- Purpose of using a particular fuel
- Reasons for not using a preferred fuel
- Energy consumption figure after end use
- Source of collecting non-commercial fuels
- Purchase vs collection of different fuels
- Preference order of using different fuels in households
- Actual price of kerosene and the statutory price of kerosene (including transportation cost)
- Energy inputs
- Per-capita income of kerosene at 1978-79 prices for individual states
- Price of other heating fuels
- Proportion of rural and urban households to the total number of households consuming energy

- Percent of rural electrification
- Proportion of literacy population to the total population
- Name of the establishment
- Type of the establishment
- Consumption of different fuels in establishment
- Reasons for shift from one fuel to another
- Distance of home from the source of collecting fuel
- Practices followed in collecting of firewood by state
- Availability of kerosene, LPG and electricity by states
- Distribution of electrified and non-electrified households
- Types of kerosene lamp used
- Average hours of use per day for each lamp
- Number of days used in a year

5. Gaps and Weaknesses

The following are some of the major gaps and weaknesses found in this report:

- As only Northern energy consumption figures were available before this study, no figures for energy consumption at the all India level were available. Thus for a detailed study the whole exercise had been extended to other parts of India on the basis of the assumption that whatever variable assoiations hold good here would also hold for the other parts of India. This was a major drawback of this study.

- In this report, the data was collected from the selected households for both rural and urban areas in India and on the basis of this, the figures for energy related items are presented at state level, but how this method of estimation was calculated from the household

level to the state level has not been discussed (for example, for the rural areas, a <u>two-stage</u> stratification was done i.e., village selection by probability proportion to population at the first stage, and household selection from selected villages, by systematic sampling, at the second state, whereas, for the urban areas, a <u>three-state</u> stratification was done, towns/cities by probability proportion to population at the first stage, selection of blocks from selected towns, by simple random sampling, at the second stage, and finally the selection of households for selected blocks, at the third stage by systematic sampling). The method of estimation for <u>rural areas</u>, where a two-stage stratification was done, is given below:

* <u>Estimate of the population mean and its variance</u>:
(Two-stage sample : Unequal first stage units : Systematic sampling of second stage units):

We suppose that the population consists of N first stage units (villages) with the ith unit containing M_i second stage units (households), where i = 1,2.....N; and further, consider a scheme of sampling in which the first stage units are selected with probability/ proportional to population P_1, P_2 ....P_N with $P_1 + P_2$ ---- + $P_N = 1$, and the second stage unit within the selected first stage units are selected by the method of systematic sampling.

Let n denote the number of first stage units to be selected in the sample, and m the number of second stage units to be selected from the ith first stage unit if included in the sample. Further, for simplicity let m_i be so determined that M_i/m_i is an integer:

Then

$$\bar{Z}_s = \frac{1}{n}\sum_{i=1}^{n}\bar{Z}_{i(m_i)} \qquad = \frac{1}{n}\sum_{i=1}^{n}\frac{1}{m_i}\left\{\sum_{i}^{m_i} Z_{ij}\right\}$$

*(Sampling theory of surveys with applications- P.V.Sukhatme; B.V. Sukhatme pp 373)

where

$$Z_{ij} = \frac{M_i}{M_0} \frac{Y_{ij}}{P_i} \qquad (i = 1,2,.....N)$$

$$M_o = \sum_{i=1}^{N} M_i$$

then $\bar{Z}_s$ is the unbiased estimate of the population mean, and its variance is given by:

$$V(\bar{Z}_s) = \frac{1}{n} \sum_{i=1}^{N} \frac{M_i}{M_o} (\bar{Y}_i - \bar{Y}...)^2 \quad + \quad \frac{1}{n} \sum_{i=1}^{N} \frac{M_i}{M_o} (\frac{1}{M_i} - \frac{1}{M_i}) S_i^2$$

Thus, will tell us about the estimate at the village level, which can be further extended to district and then state levels.

Hence, from the household level we can go to the state level:

- The standard error of average annual household consumption of kerosene cannot be in percentage terms. Instead, it has to be expressed in actual litres and it is to be expressed in %ages, the correct term to use would be the coefficient of dispersion which is defined as $\frac{* S.D.}{Average} \times 100$. But in this report standard error has been expressed in %age terms instead of in litres.

- In the various N.C.A.E.R. reports, the term systematic sampling with a random start is used. This is an incorrect term. As systematic sampling itself means a sampling where the first unit is selected by random sampling and the rest of the units are selected after a fixed distance from the randomly selected unit, it should similarly be called systematic sampling.

* Standard Deviation.

- When the towns were selected, more weightage was given to the bigger sized towns as compared to the smaller ones (since, in earlier studies it was found that bigger sized towns (population wise) showed larger variations in the average household consumption). How the proportional allocation among towns were made is not discussed in this report;

- As application of the overall sampling fraction uniformly over all income categories in each state would result in the selection of a very small number of households in the upper income groups where the variations of energy consumption and the pattern of fuel, consumption is high, so instead of overall sampling fractions relative sampling fractions for each of the L, LM, M, UN, H households were made. But how this relative sampling fraction was found is not discussed here in this report.

- In the establishment sector, a sample of units was selected from the information collected in the village schedule about the type of establishment and its energy consumption pattern but which of the sample units were selected to cover all types of rural establishments is not discussed.

- The lorenz ratio for different economic variables are given in this report without their corresponding lorenz curve, which would tell us about the amount of variation between the line of equal distribution and the distribution of economic variables. It is shown in a graphic form below.

- The proportion of weight which had been allocated to rural areas and that in the urban areas to the total, to get the total energy consumption figures at the all India level, is missing in this report.

- In this report, it is only stated that the present consumption of kerosene in households is uni-model and the distribution curve is skewed i.e. non- symmetric; nothing is given about the pattern of the distribution curve and what type of symmetricity is there i.e., positively or negatively skewed.

- The method of estimation of the total number of households (both in rural and urban areas) in India, by states is not given. This is very important to calculate the sampling fraction of each state.

- Consumption of individual fuels in different seasons such as in summer and winter according to environmental classification, is not given. This is useful information for finding out the seasonal consumption disparity of various fuels.

- Though, the data was collected on the various types of equipment used for cooking and lighting, nowhere in this report were the efficiency factors of different equipment discussed. These efficiency factors are necessary for comparison between any two consuming devices of kerosene for lighting and cooking.

REVIEW OF THE PROJECT : 'RURAL ENERGY'

- Instituto De Economia Energetica

1. Objective

In the Latin American countries, energy planning in the agricultural and cattle production sectors is neglected when animate and human forms of energy are used, taking into account traditional energy sources like the wind, the sun, hydraulic power and bio-energy. Therefore, the Instituto De Economia Energetica is working on this project on rural energy.

2. Coverage

To enable the researchers to gain adequate knowledge about the situation prevailing in the agricultural and cattle production sectors of the Latin American countries. A brief study will be carried out characterising, analysing and studying the trade and the food situation which exists and that which is required (both in terms of quantity and quality) for the population.

a) Work within the agricultural and cattle production sectors will be selected, specified and defined

(i) Agricultural production - soil

preparation, sowing, cultivation and harvesting.

(ii) Cattle production - breeding and fattening. The selection criterion is based on the climate, vegetation and soil use.

b) Only those production methods/technological activities will be taken into account which allow considerable differentation between one production process and another, so that comparisons can be easily made between any two production processes.

c) Social, economic and cultural factors, which may be affected by the sectors' production methods, will be studied in the analysis section of the project, as technological activity differs from place to place, region to region, because of these social, economic, and cultural factors.

d) Once the products have been selected the production functions will be formed separately for the different biogeographical areas, taking into consideration all different types of energy and other inputs needed to obtain the product. But since the production process will be different (or production methods) to obtain the same product, production functions will be formed taking into account both the biogeographical areas and the technological activities.

e) For each product, a matrix will be formed, showing each of the 'technological activities' and the 'biogeographical areas', and will depict the energy forms and their uses.

f) Lastly, the production functions for each product, and the matrices will provide the researchers with the following information:

i) Energy intensity per unit produced

ii) Energy profile by use and energy source

iii) Energy produced versus the energy used

REVIEW OF THE REPORT ON 'ENERGY IMPLICATION OF SOCIAL FORESTRY'

-B.Bowonder, K.Ravi Shanker, S.Shivram Prasad

1. Objective

The main objective, as has been quoted in the report has been 'to study the impact of social forestry on energy supply and environmental characteristics'.

2. Coverage

2.1 Scope of the Project

Fuelwood is still the major source of energy for the Indian rural population. Because of reckless cutting of forests, fuel- wood has become scarce. Commercial sources of energy being expensive and out of reach for the common people, the use of crop-waste and animal-waste has been diverted from 'needy manure' to be burnt as fuel for cooking. Social forestry aims to rebuild the forest resources (primarily fuelwood) through community involvement. As Eeckholm* rightly points out 'Community forestry cannot be imposed from above and carried out in the face of a hostile population. When local people are not active participants and supporters of a project, saplings have a way of disappearing overnight'.

For the purpose of this study, four villages were selected and care was taken to choose them from different socio-economic and agroclimatic regions. The four villages chosen were Balagere (Karnataka), Bhogapuram (Andhra Pradesh) and North and South Urulikanchan (Maharashtra).

E.Eekholm, Energy Policy for Rural India, Economic and Political Weekly, (special number) Aug. 1977, p 1457.

Balagere is a poor village with a low per capita income and a low level of agricultural activity, but with a well developed social forestry programme, consequently, there is no shortage of fuelwood.

Bhogapuram is also a poor village with no canal irrigation. The social forestry programme has started recently and it is mainly to raise the income of rural population by planting more fruit trees. A voluntary agency has been active in this village and has assisted villagers with cattle breeding projects and has also provided seedlings to the farmers. Out of the four village studies, this village has the highest per capita cattle population.

The other two villages are North and South Urulikanchan. These two villages are fairly well irrigated and are agriculturally productive with a high per capita income. These villages also have a well established development agency which has been giving assistance to cattle breeding programmes and because of this cattle-dung availability has increased.

To understand the impact of social forestry on energy use, the relationship between energy use and income variations in energy use with land holdings has been studied, and a special effort has been made to study the collection patterns of various non- commercial fuels.

Before forming their own questionnaire, the authors have reviewed earlier studies on energy use in rural areas. After analysing the other rural energy surveys, the authors have come to the following conclusions.

i. Fuels included differ considerably (green) manure and chemical fertilizers are excluded in many of the studies).

ii. Certain end-uses are not included (some studies examine only the domestic sector energy use, whereas others include agriculture, industries and transportation).

iii. The effects of income on energy use are not analyzed.

iv. Though energy use is a function of land holdings, only few studies include analysis of variations in energy use w.r.t. land holdings.

v. Data on the mode of collection of renewable sources of energy such as fuelwood, animal wastes and agricultural wastes, are not available in many of the studies.

vi. Energy flow matrices giving details of cross sectoral and source-to-end-use flows are not available for many villages.

vii. Many of the reported energy use studies are national averages and village level energy use information is available only on very limited locations.

2.2 Analysis of Energy Consumption Patterns

Energy use Patterns

Balagere

Fuelwood meets 69% of the energy needs for this village as fuelwood availability is good because of a well established social forestry scheme. Kerosene and diesel fulfil just about 1% of the energy needs. Per capita energy use is low with 84% consumed by the domestic sector and just 15% by agriculture. Since this village has few agricultural activities, human and animal energy consumption is also low, at around 1%.

Bhogapuram

This village has the lowest per capital energy use, but the use of human and animal energy is the highest. This is because it has the highest per capita cattle population. 34% of the total energy needs are satisfied by animal wastes and 39% by vegetable waste. 54% of the total energy consumed is by the agricultural sectors and the domestic sector uses only 24%. Bhogapuram has a considerable level of commercial and industrial activity mainly related to agricultural processing.

South Urulikanchan

This being a comparatively richer village with high level of agricultural activity, consumption of fuel-wood is less and kerosene and animal waste are usually preferred for cooking purposes. Animal wastes provide 37% of the total energy; 87% of the total energy used is in agriculture.

North Urulikanchan

The energy use pattern of this village is more or less similar to that in South Urulikanchan. This is a well irrigated and fertile village and because of this, vegetable waste availability is good. As animals are fed better fodder, animal wastes availability increases. Out of the total energy used, 55% comes from animal wastes and 30% from green manures, and around 2% from electricity. Kerosene and diesel. 85% and 14% of the total energy is consumed by agricultural and domestic sectocr respectively.

2.3 Some observations made by the authors

1. In South Uruliikanchan, more kerosene is used for cooking than fuelwood, agricultural and animal wastes. This indicates that increase in income results in substitution of other fuels by kerosene for cooking.

2. In Bhogapuram, where agricultural wastes are easily available, fuelwood consumption is low. This indicates the substitution of fuelwood by more easily available fuel agricultural waste.

3. In South and North Urulikanchan, the use of fuelwood is low.This is because of high per capita income, where people tend to use more kerosene for cooking. Another reason is that since animal waste availability is good in both the villages more animal waste is used than fuelwooc.

4. If electricity is available, then the use of diesel oil in agriculture decreases.

5. Though the percapita income in North Urulikanchan is higher than that in South Urulikanchan, the energy use percapita is higher in South Urulikanchan. This is because:

i. South Urulikanchan is a village with a higher minimum per capita income and hence the overall energy use is higher.

ii. Since, the average income is higher in North Urulikanchan the usage of diesel, kerosene and electricity is comparatively higher which is responsible for a lower use of noncommercial fuels compared to South Urulikanchan.

6. The use of fuelwood is highest in Balagere, because of increased availability through the introduction of the social forestry programmes.

2.4 Energy Use and Income Level

The paper looks at the variation in energy use pattern w.r.t. the income level which has been divided into four income groups. An analysis has been made w.r.t. fuel and enduse.

It has been observed that as the income rises the energy consumption goes up, but in the highest income group, the energy use comes down.

The animal waste usage increases with income and this is related to the cattle owning patterns and land holding size. In the case of Balagere it is the other way round, as this village has low agricultural activity and agricultural intensity is less in the higher income range.

In all the four villages, it has been found that with increase in income, use of kerosene and electricity also goes up. In the higher income group, kerosene is mostly used for cooking, whereas in the lower income level it is mainly used for lighting purposes.

The use of human and animal energy is higher in the middle income group and in the higher levels, it gets substituted by electricity and diesel.

2.5 Energy Use and Land Holding Pattern

The important observation that has been made regarding energy use w.r.t size of the land holding is that energy consumption per hectare is highest for farm sizes upto 4 hectares and for land holdings bigger than 4 hectares, energy use is comparatively less.

2.6 Collection of fuels in Rural Areas

Though the major portion of traditional fuels are still being collected either from people's own farms or from some other sources, it has been observed that increase in irrigation, higher levels of income, increased fuelwood availability, higher cattle population per capita and higher agricultural productivity, tend to improve purchasing capacity, lowering the collection of fuels from other sources in rural areas.

2.7 Energy Implication of Social Forestry

Though, social forestry has succeededin satisfying the fuelwood needs of the rural population by increasing the production of local fuelwood, it still has not managed to solve the rural energy problems satisfactorily. Giving the example of village Balagre, where Social Forestry is well established it is the village with the lowest gross productivity. The gross energy productivity has been estimated considering all productive outputs and using, all energy items as inputs. One of the reasons for the low gross productivity in Balagre may be because of the amount of fuelwood wastage. The other reason is that output represents only the extracted output and not the increase in the capital stock. To raise the productivity level, social forestry should be integrated with the other development programmes for better irrigation facilities, improved fuelwood stove efficiency, and production of charcoal.

According to the authors, if the present wood stove efficiency of 7% can be improved to 15%, then providing a free improved wood burning stove to rural areas is more economical than the cost of investment required to increase the supply of firewood. This calculation takes into account the time saved (which means more productive hours) and also reduction in consumption of fuelwood by 50%, as a result of efficient stove.

3. Survey Methodology

Hundred percent sampling was attempted in all these four villages and the field investigators were the chosen local persons and were trained for the survey by the project team. Effort has been made to keep to the minimum measuring errors. In many cases, the fuels used

were weighed to get the actual unit of use.

4. Variables Included

The survey questionnaire covered the following parameters:

1. No. of members in each household.
2. Average annual income.
3. Nature of environment.
4. Forest plantations (in hectares).
5. Role of voluntary agency.
6. Irrigation methods used.
7. Prevalance of cattle grazing.
8. Irrigated land availability.
9. Initial investment per hectare.
10. Return per hectare.
11. Occupation.
12. Number of animals; milk yield per animal and dung per animal per month
13. Use of dung, vegetable wastes, fuelwood, charcoal animal energy human energy, and green manure.
14. Usage of electricity, kerosene, diesel, coal, fertilizer etc.
15. Collection mode of fuels, fuels purchased.
16. Usage of energy for agriculture, commercial, sector, lighting, cooking etc.
17. Agricultural production.
18. Agricultural productivity per hectare.
19. Fuel production.
20. Fodder production.
21. Vegetable production.

5. Gaps

Stress should have been laid in this paper, on choosing the right species of trees to be grown, to suit the climatic and soil conditions of the areas. It has been found that under the social forestry scheme, very few species, except Eucalyptus, have been planted. In fact, Eucalyptus has been planted on the land which was previously under crop plantation. Eucalyptus does not solve any of the problems Social Forestry aims at. Since the local people do not have a high purchasing power, to close-by urban areas or to the pulp industry. This wood is otherwise also not generally preferred by the local people, as it is fast burning and proves to be very expensive. Another disadvantage of growing this species is it does not serve the ecological purpose as it does not have moisture absorption capability. Eucalyptus plantation however is steadily, increasing as it sells at good prices.

From the consumer's end, the effect of burning fuelwood on public health should have been locked into. It has been found that constant exposure to fuelwood smoke causes lung trouble and effects the vision as well*.

The transport sector has not been included in this study. Though, this sector would not be consuming much commercial fuel, there will be substantial human and animal energy input.

The authors have made a very interesting observation in this paper. According to them, it is more economical for the government to provide every rural household with a free, improved efficiency fuelwood stove as this results in national saving in terms of fuelwood and manpower productivity. This might be true if one is looking at the problem from the Government's point of view. It has been the experience of many field workers that improved stoves take more time for cooking, which does not seem to be very agreeable to rural population, as they prefer to collect extra fuelwood rather spend longer time for cooking.

Hence rural energy surveys should try to collect information, which would permit evaluation of trade off between investments in improved efficiency of energy use with those in enhanced energy supply.

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* Ref: Energy System & Development (Parikh)

REVIEW OF THE REPORT ON 'ENERGY INPUTS FOR IRRIGATED FARMING WITH MIXED CROPPING'

- C.L.Gupta
- K.Usha Rao

1. Objective

This paper aims at calculating the quantity of different energy fuels used in the agriculture sector for different agricultural activities like ploughing, sowing, irrigation harvesting and post harvest activities. An attempt has also been made to study the consumption of energy w.r.t. variables like crops, agricultural operations, land holding and yield of crops. Though, both commercial and non-commercial inputs of energy have been studied, special attention has been paid to human-energy as it still constitutes a substantial part of the inputs that go into Indian agricultural production. Human energy is used extensively in agricultural activities such as ploughing, sowing and irrigation. The other energy inputs that have been taken into account in this study are electricity, petroleum products, fertilizers, manures and animal energy.

The energy inputs in agriculture have been increasing over time. As agricultural production has increased with increased inputs of energy, policy makers have been focussing greater attention on 'energy inputs to Agriculture'.

2. Coverage

This paper analyses all the primary energy inputs to agriculture and the energy inputs are aggregated, using a common energy unit - KWH.

For computation, land under multiple cropping has been taken into account in terms of yield/ha. Mixed cropping has been characterised in terms of yield/crop- ha. Cropping intensity is defined as the summation of products of crops x ha. divided by the total ha. so as to use a single parameter for multiple as well as mixed cropping. Yield/crop-ha. can be converted into yield/unit of land by multiplying it by the cropping intensity.

There are a few interesting observations that have been made in this paper. Though the energy output/input ratios are fairly high for Indian farming as compared to advanced countries, the crop productivity per unit land is too low. To meet the requirements of a growing population, more land will have to be brought under cultivation, which will mean cutting down the forests which will have an adverse effect on the environment. Forests are also needed to provide fuelwood in the future.

The options that will be left are:

(quoting from the paper), 'Either one has to resort to medium intensity agriculture so as to balance energy inputs, productivity and employment considerations, or explore new methods of agriculture which increase productivity without increasing energy inputs or decreasing employment.

Also, since irrigation and fertilizers constitute nearly ninety percent of the energy inputs in farms using chemical fertilizers and electrically lifted water, the role of organic manures and biogas slurry as well as the efficient use of water in terms of better management by way of paved channels or new methods of irrigation such as drip irrigation and sprinklers, need to be evaluated not only on the basis of cost and environmental resource availability considerations but also from the energy inputs consideration'.

A comparative study has also been carried out for land use yields and source-wise energy inputs for one farm each in Pondicherry, Karnataka and Punjab.

The paper has tables giving the village (Ariyur) data, unit energy outputs used, average land use, yields and energy inputs, human energy input in agriculture, comparative study of energy inputs, and comparative study of land use and yield. There are figures showing, rural energy consumption relative annual energy inputs, yields and land use for various crops source-wise energy inputs- and a histogram showing operation-wise energy inputs.

3. Methodology

Two investigators collected data in a door-to- door

survey. One of the investigators belonged to the same village. This was mainly to avoid problems of communication.

A village, Ariyur, near Pondicherry was chosen for this study. This is a village having irrigated, non-mechanised farms, using multiple and mixed cropping methods. Half of the households, in this village belong to the cultivators' families and 10 percent of the total house-holds were surveyed for this paper.

4. Variables Included

While collecting data, many variables were included in the questionnaire such as the size of land holding, family data, farm characteristics and livestock categories, cropping pattern, energy requirements for pre-harvesting, harvesting and post harvesting operations and use of fertilizers and insecticides in the farms. Though an assessment of usage of the agricultural and animal wastes has been made, this has not been included in this paper.

5. Gaps

This paper does not mention:-

1. How the sample was chosen ?
2. If any classification was attempted?

   (Say, into large, small and medium families

   or according to their working conditions

   etc.)

It has been mentioned, that in the village chosen for the study, 50 percent of the households belonged to cultivator families.

- The paper fails to define the cultivator family. It's possible that only the head of the family is engaged in agricultural activity with the rest of the family members, having different occupations. Or on the

other hand, every member of the family may be working on the farm.

- The paper says that a 10 percent sample survey had been conducted in the village Ariyur. 'Table-1' of this paper, shows that the total no. of households in the village are 466, and only 23 households have been included in the sample. This is just 5 percent of the total number of households, which is too small to be truly representative of the village.

- This paper does not mention methods of estimation. It is not possible that farmers have been able to furnish all the required data from their records. For seemingly simple questions like how much diesel and electricity was consumed for different operations, farmers might not have an answer. Some norms must have been used to arrive at the needed figures. These are important and should have been covered.

Since, this paper has paid special attention to human energy inputs in agriculture, it becomes important to state how the human and also animal energy used in work has been computed.

In this paper, energy equivalents for different energy sources are given in terms of KW (atleast for most of the energy sources), whereas energy consumption has been calculated in the energy unit KWH. Conversions need to be made and mentioned.

It has been stated in this paper, 'energy output/ input ratios are fairly high for Indian farming however the crop productivity per unit land is much less'. This observation itself underlines the importance of looking at energy inputs w.r.t. land. In the analysis, land should have been taken in consideration, to give a better view. The paper gives energy consumption per tonne of agricultural product. Another reason, why land use or the size of the land holding should have been taken into account is that the other studies have shown the variation of energy inputs with the size of the land holding. the NCAER* study reveals that inputs of animate

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* Energy consumption in the Northern Region.

energy decreases and use of fuels increases with the increase in the size of holding.

Though data have been collected in terms of the size of land holdings (large, small, medium and marginal farmers) this has not been analysed, the reason given is that the cropping pattern is the same for all the sizes of land holdings. But this point is not too important, considering that this study aims at looking at the energy-consumption pattern. It has been found that energy consumption per hectare decreases with the increase in the size of the land holding for the same productivity level.

REVIEW OF THE REPORT ON 'ENERGY USE IN RURAL INDIA'

- Roger Revelle

1. Objective

This paper by Roger Revelle gives the National Energy consumption statistics. The author observes that the energy consumption for developing countries is 'seriously underestimated' as most of the international statistics are based on commercial energy consumption. In the developing countries, the author feels that nearly half of the energy requirements are met by 'traditional' sources of energy - human and animal energy, firewood, crop residue and animal wastes, which are generally not accounted for.

2. Coverage

This paper describes in detail how the human and animal energies used for work have been estimated (which will be discussed later in this paper). Also using certain norms or adopting other authors estimates, the author has arrived at consumption statistics for both traditional and commercial fuels in rural India, for the year 1970-71. A comparison has also been made between the use of energy from different sources for rural India and the United States.

2.1 Estimation of Human Energy

The paper discusses the various methods used by different authors to compute the human energy used for mechanical work.

Pimental estimates are based on the input of the total food energy and assumes that the worker works for 40 hours in a week.

Makhijani and Poole also consider the energy in the food intake as gross energy input for human labour and assuming the 'energetic efficiency' of 3 percent estimates the work output per capita.

Passmore, Durnin and White estimate the energy used for different activities from measurements of oxygen consumed or carbon dioxide exhaled.

To estimate the human energy expenditure in rural India, the author uses the estimates of Passmore, Durnin and White as this estimate in the lowest and is justified by the fact that there is considerable underemployment in India.

Estimated hours worked per year for various activities are based on the occupation of the rural population as given in the 1971 census of India.

2.2 Animal Energy

The output of useful work per hours for a bullock is estimated by taking the gross energy input (fodder intake) minus energy in dung and energy in milk and dividing it by the numbers of hours worked.

The author assumes 'energetic efficiency' of about 19 percent and to estimate the total animal energy utilized in rural India the assumption made is that out of the total population of bullocks in India, 83 percent of the work done by bullocks was carried out in the rural area.

2.3 Locally Produced Fuels

Animal dung and crop-residue fall under this category. The estimates for the consumption of animal dung and crop residue arrived at by many authors have been given. For the purpose of this study the author uses Henderson's estimate for dung consumption. According to Henderson, a total of 68 million tons of dung was used as fuel, of which 83 percent was burnt in rural areas, giving a 56 Kg. per capita dung consumption in rural India.

Using Makhijani and Poole ratios of straw to grain for rice, wheat and sorghum as 2.9, 1.75 and 0.85 respectively, estimates have been made on straw and chaff residue availability from total foodgrains production in the country. It has been assumed that about one fifth of the total production of straw and

chaff used as fuel and that 83 percent was consumed in rural areas.

2.4 'Commercial' Energy Sources

Estimates are given for consumption of nitrogen in chemical fertilizers in India and the quantity of naphtha and other light petroleum fractions used as a feedstock and as a source of energy in manufacturing a ton of nitrogen, consumption estimates for petroleum products in farm (by tractors and for irrigation) and in rural households for cooking have been made. It has been assumed that percapita household consumption is the same in rural and urban areas . Henderson's estimates for coke consumption in rural households in 1970-71 are given which are based on his observations that its per capita usage is at least twice as high in cities as in rural areas. Average per capita electricity for rural areas was estimated assuming that half of the total electricity consumed was in villages. The author has tried to justify this assumption by noting that except for irrigation, per capita consumption of electricity is lower in rural than in urban areas, but since villages containing 36 percent of the rural population i.e. 160 million people were electrified and the urban population was only 110 million people, it can be assumed that half of the house-hold use for electricity was in the rural villages.

2.5 Fuel Efficiency in Cooking

The efficiency of stoves used in rural India is very low, - around 9 percent. Comparing the energy use per calorie of food for cooking in India and the U.S. it has been found that it is higher in India than U.S. energy use for cooking and refrigeration combined. It is feared that if the same efficiency stoves are to be used there will be complete deforestation in India in 22 years time. By using the improved efficiency stoves, it will help in the conservation of fuelwood, and also, to avoid deforestation, intensive reforestation programmes will have to be started.

2.6 Comparison of the U.S. and Rural India

Disparity in per capita energy use in rural India is alarming. The U.S. annual per capita energy expenditure is nearly 32 times that in India. The difference in per capita use by the farm population is equally unbalanced with U.S. consumption being 50 times than of India's. It

is interesting to note that in India, major portions of the energy consumed are directly related to food i.e. on farms, food processing industries and home refrigeration and cooking, (nearly 82 percent) whereas for the U.S. it is about 13 percent.

Out of the total energy consumed in India, 89 percent of the total requirement was met by traditional fuels and in the U.S. contribution from traditional fuels was negligible, with fossil fuels and hydro-electric power providing nearly all the needed energy.

The author has also compared the foodgrain prices in these two countries for the year 1970-71. His findings, reflected that human and animal work is more expensive than mechanical work based on fossil fuels.

Roger Revelle makes a very valid observation that 'more energy is needed in India'. The population of the country is increasing rapidly and since there will be two time as many mouths to feed, production of food-grains will have to be increased and as more and more land will be unavailable for cropping. Agricultural production will have to be increased with intensified cropping i.e. through modernisation of agricultural sector. Besides this, more energy is needed to improve the quality of life which applies specially to rural population.

An attempt has also been made to explore the possible sources of energy which can be expected to provide for the increasing demand for energy.

In the year 1970-71 fossil fuels and hydroelectric power seemed to have best prospects.

3. <u>Gaps</u>

There does not appear to be any scientific basis on which the author either bases his estimates or borrows other author's estimates. Nowhere does he give any reason for adopting a particular estimate for making any assumption. Stating few examples:

1. The author uses Passmore, Durnin and White's estimates for calculating human energy work-output, which was based on the measurement of oxygen

inhaled or carbon dioxide exhaled. It has not been mentioned how the calculations are made to estimate the human energy efficiency from inhaling and exhaling rate, and why the author prefers this estimate to others. (This being the lowest estimate does not seem to be justified reasoning).

2. On what basis the assumption, that 83 percent of the work done by bullocks was carried out in rural areas, or 83 percent of cow-dung and straw consumption was in rural areas was made, has not been mentioned.

REVIEW OF 'RURAL ENERGY SURVEYS IN INDIA'

-Ashok V.Desai/NCAER

1. Abstract

The purpose of the paper is to gain an insight into the paper on 'Rural Energy Surveys in India' by Ashok V. Desai, and to critically examine it. The important points, which have not been covered are discussed below and a questionnaire based on the available information is prepared in order to file the inadequacies in the existing data.

2. About the Paper

The object of the paper is to review the level of current knowledge about rural fuel consumption and production in India and to make suggestions about how the efficiency may be improved. Since the data on the consumption and production of rural fuels is not collected regularly, a sample survey based on a detailed questionnaire, has to be set up in order to fill gaps and compensate for the inadequacy in existing data. The questionnaire will be sent to selected rural sectors and the data collected will be reviewed and analysed in combination with existing information and inadequacies will be assessed.

3. Findings of the Paper

Ashok Desai's paper examines in detail the work of about 60 persons and institutions, who have studied rural fuel consumption and production. The important points, which Desai feels are generally not covered in this aspect, are discussed under the following broad heading:

i) Inadequacy of data on the cost of the fuels

The current concern over the recent energy problem, arises out of the feeling that the cost of the fuel is showing a steady rise over time. Thus, in a rural energy survey, due emphasis should be given to the cost of the fuel and the trend of this cost, because it is only in terms of the cost that one can tell whether the fuel is more scarce in one place as compared to another. The

variables (such as space and time), which bring out the variations in the cost, should also be clearly defined.

Since consumption differs from consumer to consumer, while data is collected for consumption of the different fuels, income-wise classification is very necessary in order to guage consumer behaviour.

ii) Problem of Aggregation of Inputs

There are unbridgeable quality differences among the services provided by the different fuels. What is required is a quality index by which each fuel can be measured - an index which would reflect the value of a fuel to a consumer. A quality index could facilitate in the calculation of the total amount of fuel (of different types) used in a process. The method of doing this, is at present, that of applying energy equivalents (which measure the maximum heat produced by a fuel on complete combustion) of different fuels as a quality index. Since these energy equivalents are obtained experimentally, and there is a lot of variation because of differences in quality, it is not correct to apply the same energy equivalent.

Data has to be collected on actual energy consumption (if we take the energy equivalents of the different fuels, as weights, the resulting sum if called the actual energy consumption), and the useful energy consumption (the product of the energy equivalents and the proportion of energy actually utilized). If there is a considerable gap between the two, there is an indication that improvement is needed in the efficiency of consumption.

iii) Inadequacy of Data on Woody Fuels

In the fuel survey, it is important to disaggregate woody fuels, and the disaggregation should depend on the source of the supply, energy equivalents, and the consumer preference list which is based on the demand price, the price which reflects the quality preference.

In India, consumption figures for firewood are generally available, but no attempt has been made at getting production figures (i.e. annual harvest of logs, twigs and branches). Thus, while data is collected for

biomass, it is necessary to collect data on its production, collection and consumption, so as to find out the gap between production and consumption. When data is collcted for biomass, stress should also be laid on the resources used for acquiring the fuel and the alternate uses of these resources.

Since labour is the major input for the collection of fuelwood, it would be relevant to collect data on the amounts of fuelwood collected age-wise and sex-wise and to calculate the time being spent on the collection of this fuelwood.

The consumption of fuelwood depends, to a large extent, on its consumption, so an attempt ought to be made to find out the straw-grain ratio and whether the straw is efficiently utilized or not, involving information on how much of the straw is used for cooking and how much is used for fodder, etc.

Lastly, the data on consumption and production of fuel should obviously be in the same unit so that it is easily comparable.

iv) Inadequacy of data on cow dung

It was found that the supply and demand balances for dung, in the Indian context is based on the daily out-turn of dung per animal. This however, does not seem rational. Since the waste product of an animal is based on its fodder intake, the demand-supply balance of dung has to be worked out on the basis of fodder consumption and its out-turn as a waste product. It would, therefore, be advisable to have some sort of classification among the different animals according to their fodder intake, and then try to estimate the out-turn of dung per animal.

Since dung can be used as fuel and as a manure and because its consumption as regional as well as seasonal disparities, an attempt must be made to find out the quantity of dung used and the quantity of dung used as manure, separately. This has to be do done from region to region, with respect to the different seasons.

v) Inadequacy of Data on Labour Cost

A rural fuel survey would be incomplete without consideration for the labour cost of fuel collection of fuel collection. So data on the labour cost of collection of fuel is an important factor. (The labour cost of collection is defined as the number of worker hours multiplied by the energy equivalent of the fuel).

Since labour cost is measured in terms of the time factor, a distinction should be made in the type of labour according to age and sex because it is noted that an adult male can do more work than a child or a woman in the same amount of time.

There is a way of measuring the various kinds of animate work in a single unit, it is necessary to classify the work according to its energy requirements (i.e., light, medium or heavy). Weight is relatively easy to measure and continuous weight records should be maintained as part of any work on animate energy.

vi) Methodology

In the section under methodology, the author has touched upon a few more points regarding rural energy surveys.

a) Scope :

- A rural energy survey need not cover both animate and inanimate energy. If however, it does, the two should be aggregated. A distinction should be made between energy used for heat and energy used for work.

- A rural energy survey should also include a survey of the resources used for collecting and acquiring the fuel, and should also consider the alternative uses of these resources.

- Among the sources in this case, labour and land are the most important ones. Land must include all the land used for this purpose and not just the cultivated land.

- Later considering fuelwood and dung, the stock of trees and live-stock should be carefully considered. Other resources, such as pumps and tractors, should also be included if they play an important role.

b) Exploration:

- Before formulating a questionnaire and starting the survey, it is better to get an idea of how things actually work in the field. For this, a pilot study or a sort of pre-test is advisable. This should be done with a view to getting information on consumer preference regarding fuels, the quality of consumption of fuels, the effort put into obtaning the fuels, income levels, and the allocation of resources, etc.

- At this stage, details regarding this information is not so important. Other noteworthy points are the cooperation of the local persons, their influence on one another regarding the questionnaire and their biases; if any.

c) Sampling :

The advantage of selecting a sample rather than using the population is that a sample of time, cost and effort saving. A sample must however, be a proper and complete representation of the poplation. The choice of the type of sample (simple, stratified, systematic, multistage, etc.) is also very important for ensuring homogeniety of classification, and of course, the listing of the population makes the task of selecting these samples much simpler.

d) The Questionnaire :

Finally, one has to consider the body of the questionnaire. Every questionnaire should naturally start with questions establishing the identity and characteristics of the respondant. The purpose of this is to ensure that the respondant can be traced out if necessary, at any stage. In the later stages of the questionnaire, questions are asked in accordance with the information

required, and they should be placed in a simple and systematic fashion, so as to be easily understood by everyone. An attempt should also be made to limit the number of questions.

4. Points of importance not covered in the paper

Other points of importance and which deserve some attention when studying aspects of rural energy and which have not been covered in this paper, are discussed below:

- In most cases, data is not collected regularly concerning the flow of energy from the source of supply of the fuel to its end use.

- When collecting data on fuel use, it is also necessary to obtain data on the type of equipment used on the various related activities, i.e the types of stoves used for cooking, the types of lamps used for lighting the kerosene stoves, appliances, pumpsets, tractors, electric motors etc.

- The pattern of use of the various crop residues on the construction material.

- It would also be necessary to estimate the moisture content of each fuel so that the calorific content of each fuel can be accurately estimated.

- It is important to collect data on the patterns of energy distribution and ownership - this information answers questions about where each socio-economic group gets its supplies of energy; the mechanisms (ownership, exchange, purchase, or patronage) through which each group obtains its supply of food, fuel and fertilizer; and the relationship between energy, land ownership and the labour structure of the village.

- Measurements should be consistently taken so as to standardize quantities even when fuel is used in non-standard units, such as bundles, bags back loads, head loads, etc.

- Data should be collected regarding the relation ship of fuel availability and agriculture, in terms of quantity and the types of residues related to crop rotations, and the availability of livestock and manure, etc. over different seasons.

5. Concluding Remarks

It has been seen that inadequate coverage, and problems of definition, measurement and aggregation of animate energy and different forms of fuels, often mar most studies. Available information does not sufficiently indicate the regions and/or activities where energy shortages are being felt and are acting as imbalances. Also, very few studies have described the process of generation and use of these traditional sources, by different households. This is important information for projecting demand-supply forecasts, as well as for evaluating new technologies/programmes.

Thus, it is important to clearly outline the objectives and scope of a survey, since the survey parameters - such as the type of information to be collected, the type of respondants, investigations and methodology - depend on the policy issues in question.

Before setting up this questionnaire, a review of the existing literature and data on rural energy consumption and production pattern has been carried out. The points that emerged on the inadequacy of the data have been taken into account and an attempt has been made to fill-up the gaps that have been felt in the current available data on rural consumption of energy.

The Questionnaire

The questionnaire has been divided into two schedules: (i) village and (ii) household.

The village schedule establishes the identity of the village by seeking information regarding its population, number of households, net sown and cultivated area, its distance from block and district heatquarters, modes of transport, type of establishments existing and also

different energy sources that are being used in the village.

The question in the household sector are framed to provide insight into the rural energy consumption pattern. Both commercial and non-commercial energy sources are included:

The various sections in the Household Schedule are:

1. IDENTIFICATION: This section establishes the identity of the household and obtain information regarding the head of the Household, size and annual income of the Household.

2. HOUSEHOLD PARTICULARS: Particulars of the members of the household are recorded in this section.

3. LAND HOLDING PARTICULARS: This section will record a detailed information, season-wise, on the area that is operational, cultivated and irrigated and information will also be collected on the types of agriculture machinery and modes of transport owned or hired by the household.

4. LIVESTOCK PARTICULARS: In this section data will be collected on the livestock holdings of the household and season-wise estimates of quantity of cow-dung purchased and collected, its selling and buying prices, sources of collection of dung-cake and also the proportion used as manure or as a fuel.

5. FOOD GRAIN CONSUMPTION: This section records information on the quantity of food grains consumed by the household, price they paid and quantities produced and/or purchased.

6. ENERGY CONSUMPTION: In this section, estimates of commercial and non-commercial fuels consumed for various end-uses will be obtained. This section also covers the prices of the fuels at which fuels are purchased or sold, quantity purchased or collected, source of collection and purchase.

7. FARM OUTPUT: The information will be collected on the production of main crops and their by-products, total and irrigated area under the crop, and quantity of

the main crop or by-products sold, retained or received (as wages).

8. FERTILIZER INPUTS: In this section, data will be recorded on organic and inorganic fertilizers consumed crop-wise and also obtains estimates on quantity purchased and collected, source of collection and the price paid.

9. LABOUR INPUTS: Information regarding human and animal labour employed on the farm is collected in this section.

10. TRANSPORTATION: This section will account the energy consumption in transportation for agriculture purpose. Information will be collected on the mode of transport used, mileage of the vehicle, average distance covered in a day and purpose of transportation.

11. GOBAR GAS PLANT: This section seeks information on the owned and community Gobar Gas Plants, regarding their size, biomass consumed, capital invested, average time of operation and the purpose for which produced gas is used.

12.& 13. HOUSEHOLD CONSTRUCTION AND INDUSTRY: This section will deal with energy consumption concerning Household Construction and Household Industry.

SCHEDULE-A
(Village Schedule)

1. INTRODUCTION:

1. State..
2. District.......................................
3. Block..
4. Village..
5. Population (village)...........................
6. Number of households (villge)..................
7. Distance of the village from
   (a) Block headquarterrs (km)...................

   (b) District headquarterrs (km)................

II. LAND UTILIZATION STATISTICS (In Hectares):

1. Total area of the village
   according to land records......................
2. Net area sown..................................
3. Current fallows................................
4. Net cultivated area............................
5. Fallow land other
   than current fallows...........................
6. Other uncultivated land
   excluding fallow land..........................
7. Cultural waste land............................
8. Land not available for cultivation.............
9. Total land under irrigation....................
10. Total idle land in the village................
    [(5)+(6)+(7)]

III TYPE OF ESTABLISHMENTS:

Which are the various types of establishments present in the village? (Please encircle).

Agriculture......................1

Commerce.........................2

Domestic.........................3

Rural Industries.................4

Transportation...................5

Communication....................6

Construction.....................7

Schools..........................8

Hospitals........................9

Banks...........................10

IV. ENERGY SOURCE:

Which are the various sources of energy used in the village? (Please encircle).

(i) Commercial Fuels:

Electricity......................1

Diesel Oil.......................2

Furnace Oil......................3

Coal/coke........................4

Kerosene.........................5

Petrol...........................6

(ii) Non-Commercial fuels:

Firewood..........................7

Dung Cake.........................8

Vegetable waste...................9

Charcoal.........................10

(iii) Animate sources:

Man power........................11

Draft Power......................12

(V) GOBAR GAS PLANTS:

(i) How many community gobar gas plants are there?

1. Respondent's Name............................

   Address....................................

   Signature..................................

   Date.......................................

2. Name of the field Investigator...............

   Address....................................

   Signature..................................

   Date.......................................

3. Name of Controlling/
   Supervising Officer..........................

   Designation................................

   Address....................................

   Signature..................................

   Date.......................................

SCHEDULE - B

(Household Schedule)

1. INTRODUCTION:

1. Sample household number......................
2. Name of the head..............................
3. Village.......................................
4. Tehsil..
5. District......................................
6. State...
7. Household size (family size).................
8. Annual income of the household...............
9. i) Respondent's name.......................

   ii) Relation with the head of the household..................

10. Type of the region where the household is present .... (Please encircle)

    Hilly..............1

    Desert.............2

    Plain..............3

11. Date of interview............................
12. Ow.. [illegible] farm (Yes/No)

    If yes. (in local units).....................

13. Distance of the farm from the household......
14. Distance of the household from

    i) Block headquarters......................

    ii) District headquarters...................

II. HOUSEHOLD PARTICULARS:

S. NO.	NAME	SEX	AGE	MARTIAL STATUS	QUALIFI- CATION	OCCUPAT- ION	
						Primary	Secondary

III. LAND HOLDING PARTICULARS : (Local Unit.......)

1. Total land owned by the household for cultivation...................

2. Total operation holding, season wise

   i) Kharif.....................

   ii) Rabi.......................

   iii) Zaid.......................

3. Area cultivated.....................

   i) Kharif....................

   ii) Rabi......................

   iii) Zaid......................

4. Total land under irrigation

   i) Kharif....................

   ii) Rabi......................

   iii) Zaid......................

5. Pastures...........................

6. Fallows............................

7. Operational holding under :

i) Plantations....................

ii) Orchards.......................

8. Please fill up the following table for machinery holding for the last reporting month.

Sl. No.	Source	Horse Power	Number	Total time used per day	Fuel consumption (Qty.per day)	Purpose
1.	Stationary engine					
2.	Tractors & power tillers					
3.	Trucks					
4.	Irrigation pump i. Diesel ii.Electirc					
5.	Agriculture pumping (post harvest technology)					
6.	Any other (specify)					

9. What modes of transport used by you for transportation purposes ?

1. ....
2. ....
3. ....
4. ....

5. ....

6. ....

IV. LIVESTOCK PARTICULARS

Animal	Bullocks	Cows	Buffaloes	Goats	Camels	Pigs
Age						
Average Output of Dung						

(local unit)

1. Total amount of dung produced in the household ....

2. Moisture content in dung cakes, in

   i) Summer......................

   ii) Winter......................

   iii) Monsoon.....................

3. Average consumption of dung cake by the household/day

   i) Summer......................

   ii) Winter......................

   iii) Monsoon.....................

4. Whether collected ....Yes/No

5. If the cow-dung is collected, then (Answer in Local units)

   i) How much is used for household, per day......

      a) Winter......................

      b) Summer......................

c) Monsoon......................

ii) How much is sold per day....................

a) Winter........................

b) Summer........................

c) Monsoon.......................

iii) At what price it is sold...........(Rs./local Unit)

a) Winter........................

b) Summer........................ .

c) Monsoon.......................

6. If the dung is not sufficient/no cattle/not collected, then:

i) How much is purchased daily..................

a) Winter........................

b) Summer........................

c) Monsoon.......................

ii) What price is paid for it

a) Winter........................

b) Summer........................

c) Monsoon.......................

7. Of the total cow-dung consumed, what proportion is used as:

a) Manure........................

b) For burning...................

V. FOODGRAIN CONSUMPTION:

Please indicate your monthly consumption of foodgrains (cereals and pulses) in the last reporting month:
(Summer)

S. No.	ITEM	Total quantity cnsumed in local unit	Purchased (Qty)	Price paid	Own produced (Qty)	Received as wages (Qty)
1.	Rice					
2.	Wheat					
3.	Maize					
4.	Bajra					
5.	Jowar					
6.	Pulses					
7.	Vegetables					
8.	Meat/ Fish					
9.	Milk					
10.	Tea/ Coffee					

VI ENERGY CONSUMPTION:

a. Please indicate type of fuels used by you, their end uses and whether purchased/collected. Please check.

S. No.	Fuel	End-Uses				Entirely purchased	Entirely collected	or both
		Cooking	Lighting	Water heating	Space heating			
1.	Coal							
2.	Soft Coke							
3.	Kero-							

sene
4. Electricity
5. Charcoal
6. Gobar gas
7. Dung-cakes
8. Fire-woods(s)
9. Dry leaves
10. Saw dust
11. Wood shaving
12. LPG
13. Vegetable waste
    a. rice straw
    b. wheat straw
    c. any other (specify)
14. Any other (specify) (incl. mixed fuels)

---

b. Please indicate your monthly consumption of these energy sources, according to their end-uses.

Local Unit	S. No.	Energy Source	Cooking			Lighting			Water heating			Space heating		
			S*	W*	M*	S	W	M	S	W	M	S	W	M
		Commercial												
	1.	Coal												
	2.	Soft coke												
	3.	Electricity												
	4.	Kerosene												
	5.	LPG												

Non-commercial

1. Charcoal

2. Dung-cake

3. Firewood
   i. logs
   ii. twigs

4. Vegetable Waste
   i. rice straw
   ii. wheat straw

5. Dry leaves

6. Saw dust

7. Wood-shoving

8. Any other (specify)

---

* S - summer
W - winter
M - monsoon

i) Non-commercial Fuels:

Please fill in the following table

Quantity : Local units
Price : Rs/local units

Fuel	Quantity purchased	Quantity collected	If purchased price paid
Charcoal			
Gobar gas			
Dung cake			
Firewood(s)			
Logs			
Twigs			

Dry leaves

Saw dust

Wood shaving

<u>Vegetable waste</u>

Rice straw

Wheat straw

Any other
(specify)

---

ii. Commercial Fuels:

Indicate the sources of purchasing, commercial fuels and the price paid for them.

Qty........local units
Price......Rs/local unit

Fuel	Quantity Purchased		Price Paid	
	From ration shops	From other places	At ration shop	Other place
Coal				
Soft-coke				
Kerosene				
Electricity				
L.P.G.				
Gobar Gas				

VII. FARM OUTPUT:

Please fill in the following table and also indicate high yielding varieties and Non-High yielding varieties.

i) Kharif season:

Quantity......(Local units)
Area..........(local units)

---

1. Crop grown

2. Area under the crop

3. Area irrigated

4. Total production

5. Quantity paid out(for any reason)

6. Total quantity (4 minus 4)

7. Quantity sold

8. Quantity retained
   - i. for household consumption
   - ii. for seeds
   - iii. for cattle feed
   - iv. for payment as wages

9. By products
   1. Specify
   2. Qty.produced
   3. Qty.sold
   4. How much used as
      - i. fuel
      - ii. cattle feed
      - iii. other purposes

---

ii) Rabi reason

Quantity......(local unit)
Area..........(local unit)

1. Crop grown
2. Area under the crop
3. Area irrigated
4. Total production
5. Qty. paid out (for any reason)
6. Total quantity (4 minus 5)
7. Quantity sold
8. Quantity retained
   - i. for household consumption
   - ii. for cattle feed
   - iii. for payment as wages
9. By products
   1. Specify
   2. Quantity produced
   3. Quantity sold
   4. How much used as
      - i. fuel
      - ii. cattle feed
      - iii. other purposes

iii) _Zaid Season_:

Quantity....(local units)
Area........(local units)

1. Crop grown

2. Area under the crop

3. Area irrigated

4. Total production

5. Quantity paid out (for any reason)

6. Total quantity '(4 minus 5)

7. Quantity sold

8. Quantity retained
   - i. for household consumption
   - ii. for cattle feed
   - iii. for payment as wages

9. _By products_
   1. Specify
   2. Quantity produced
   3. Quantity sold
   4. How much used as
      - i. Fuel
      - ii. Cattle feed
      - iii. Other purposes

Crop Output received

(Local unit............)

S. No.	Crop	Received as wages	Received as share from leased out land

Main products

By product

VII FERTILIZER INPUTS

Please fill-up the following table

(Local unit...........)

S. No.	Fertilizer Inputs	Crops (Quantity)
1.	Organic Fertilizer	
i.	Farm yard manure	
ii.	Green manure	
2.	Inorganic fertilizer	

Local unit................

S. No.	Fertilizer Inputs	Purchased	Collected	Sources of Collection			Price paid (Rs/ Local Units
				Own Farms	Road side collection	Recd. as wages	
1.	Organic Fertilizer						
	a. Farm yard manure						
	b. Green manure						
2.	Inorganic Fertilizer						

IX LABOUR INPUTS : (for all operations excluding irrigation)

S. No.	Energy Sources	Unit	Quantity consumed	Salary paid for the hired labour/ animal	How much hour spent per day in the farm
1.	Human				
	i. Family labour	Man hrs			
	ii. Hired labour	Man hrs			
2.	Animate				
	i. Own	hrs			
	ii. Hired	hrs			

X. TRANSPORTATION:

Please indicate the modes of transport used for agriculture purpose

S. No.	Mode	Fuel	Number of vehicles	Price paid per unit	Mileage in terms of km/ lit.	Average total distance (km) covered/ day	Purpose of transportation
1.	Tractor						
2.	Truck						
3.	Bicycle						
4.	Jeep						
5.	Animal cart						
6.	Other (specify)						

XI. TRANSPORTATION: Please indicate the modes of transport used for domestic purpose:

S. No.	Mode	Fuel	No.of vehicles	Price paid per unit	Mileage in terms of km/lit.	Ave. total distance (km) covered/day	Purpose of transportation
1.	Scooter						
2.	Car						
3.	Motorcycle						
4.	Train i.Diesel ii.Electric iii.Steam						
5.	Tractor						
6.	Bus						
7.	Truck						
8.	Bicycle						
9.	Animal cart						
10.	Animals						
11.	Jeep						
12.	Others (specify)						

XII. GOBAR - GAS PLANT :

A. OWN GOBAR-GAS PLANT

1. Do you have your own gobar-gas plant?....... (Yes/No)

2. When was it installed.................(years)

3. Size of your plant...................(cu.ft)

4. Dung consumption per day....................

5. Vegetable-waste consumption per day..........

6. Total time the plant is used per day.........

7. Gas used for:

   (i) Lighting..................(Yes/No)

   (ii) Cooking...................(Yes/No)

   (iii) Space-heating.............(Yes/No)

   (iv) Water-heating.............(Yes/No)

8. If the plant is kept unused, then:

   (i) Reason for not using it................

   (ii) For last how many days/ months it is unused ....

9. Capital invested for setting up gobar gas plant ....

B. COMMUNITY GOBAR-GAS PLANT :

1. Are you using community gobar-gas plant ....(Yes/No)

2. When was it installed?................(Year)

3. Size of the plant....................(cu.ft)

4. Dung consumption per day....................

5. Vegetable - waste consumption per day........

6. Total time the plant is used per day.........

7. Gas used for

   (i) Lighting..................(Yes/No)

   (ii) Cooking...................(Yes/No)

   (iii) Space-heating.............(Yes/No)

   (iv) Water-heating.............(Yes/No)

8. If the plant is kept unused, then

(i) Reason for not using it...............

....

(ii) For last how many days/months it is unused..............................

XIII. ENERGY CONSUMED FOR HOUSEHOLD CONSTRUCTION:

If the particular household selected is under construction then fill up the following table:-

S.No.	Source	Unit	Quantity	Purpose
1.	Electricity	Kwh		
2.	Diesel	K.lit.		
3.	Petrol	K.lit.		
4.	Kerosene	K.lit.		
5.	Man power	Man-days		
6.	Animate power	Hours		

XIV. HOUSEHOLD INDUSTRY:

1. Is there any kind of cottage industry in the household......................(Yes/No)

2. If statement No.. 1, is yes then fill up the following table.

Type of Industry	Source of energy	Unit	Energy consumed

XV. If the household does not purchase all its requirement of firewood, then what are the sources of collection?

S.No.	Sources of collection	Check	Proportion to total collection
1.	Own farm		
2.	Road side		
3.	Nearby forest		
4.	Neighbours farm		
5.	As wages		
6.	Exchanged		

If you own any tress, fill in the following table:

S.No.	Name	Fruit trees	Other trees
1.	Number of trees at the beginning of the year		
2.	No. of trees cut during the year		
3.	Quantity of wood i. as fuel ii. as wood		
4.	Quantity sold i. as wood ii. as fuel		
5.	No. of trees replanted		

How often the trees are cut......................

Sources of collection of animal dung/crop wastes, if not purchased

Fuel	Own animate	Road-side collection	Wages in kind
1. Animal dung			
	Own Land	Other's Land	Wages
2. Vegetable/ Cropwaste			